

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

HONG *et al.*

Application No.: 10/767,854

Filed: January 30, 2004

For: **Oxidation Protective Coating  
Method for Carbon/Carbon  
Composites**

Confirmation No.: 2978

Art Unit: 1792

Examiner: Ngampa, Briget P.

Atty. Docket: 2236.0070000/JUK/SMW

**Declaration of Soon Hyung Hong, Yang Ho Bae, Ji Young Song and Hee  
Yeoun Kim Under 37 C.F.R. § 1.132**

*Attn: Mail Stop Amendment*

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

Sir:

The undersigned Soon Hyung Hong, Yang Ho Bae, Ji Young Song and Hee  
Yeoun Kim declare and state as follows:

1. We are co-inventors of the invention described in one or more of the pending claims of the captioned application.
2. It is our understanding that claim 5 of the captioned application was rejected by the Examiner in the Office Action of February 11, 2008, over Galasso et al. (U.S. Pat. No. 4,425,407), Booth et al. (U.S. Pat. No. 5,330,789), Holko et al. (U.S. Pat. No. 5,021,107) and Hanzawa et al. (U.S. Pub. No. 2001/051,258).
3. It is our understanding that claim 5 as rejected by the Examiner recited: "The method of claim 1, wherein the heat-treating in (b) is performed at a temperature

of about 1400 °C to about 1600 °C under a pressure of about 10 mTorr to about 1000 mTorr.

4. It is our understanding that the features of claim 5 have been incorporated into amended claim 1 in the present Amendment and Reply, and that claim 5 has been cancelled. Amended claim 1 recites: "A method of making an oxidation protective coating for a carbon/carbon composite, the method comprising:
  - (a) spraying a mixture comprising a vehicle liquid and Si powder on the carbon/carbon composite and drying the mixture to remove the vehicle liquid;
  - (b) heat-treating to allow the carbon/carbon composite to be impregnated with the Si, thereby forming an SiC layer and an Si layer, wherein the heat-treating is performed at a temperature of 1400°C to about 1600°C under a pressure of about 10 mTorr to about 1000 mTorr; and
  - (c) oxidizing the Si layer to form an SiO<sub>2</sub> film.
5. The temperature range of the heat treating in (b) is critical, and the considerations for the heat treating include (1) economic cost considerations, and (2) functional considerations, including the complete and uniform infiltration of the Si on the carbon/carbon composites.
6. To minimize the economic costs associated with heat treating, we have found that high temperature processing above 1600 °C is not necessary. This point was identified in the captioned application at paragraph [0044].

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9. The known melting temperature of Si is 1412 °C. To increase the diffusion speed of the Si into the pores, the temperature should be increased near to or higher than the melting point of Si. In order to investigate temperatures which result in an effective fluidity of Si, heat treating temperatures between 1400 °C ~ 1600 °C were attempted.

10. When the heat treating was performed near the melting point ( $1412^{\circ}\text{C}$ ), Si fluidity increases as shown in Fig. 2 and the Si adheres to the carbon/carbon composite.

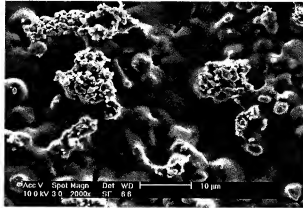


Fig. 2. Carbon/carbon composite Si-infiltrated at  $1412^{\circ}\text{C}$  (melting point).

However, Fig. 2 demonstrates that while Si coats the composite in some areas, other areas contain pores. The pores result from the insufficient fluidity of Si, indicating that the heat treating should occur at a temperature at or above the melting point.

11. When the heat treating temperature increased to  $1425^{\circ}\text{C}$ , the carbon/carbon composite was coated uniformly as in Fig. 3.

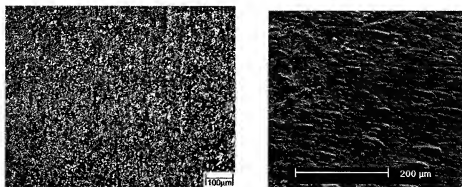


Fig.3. Carbon/carbon composite Si-infiltrated at 1425 °C

The uniformly coated Si on the carbon/carbon substrate improved oxidation resistance.

12. The data presented herein demonstrates the critical nature of heat treating the Si-coated carbon/carbon composite to impregnate the initial coating layer and cracks in the initial coating later with Si.

13. I have read and understand 37 C.F.R. § 10.18(b) and (c).

2008.5.30  
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*Soon H. Hong*  
Soon Hyung Hong

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Soon Hyung Hong

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Yang Ho Bae

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Ji Young Song

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Hee Yeoun Kim

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